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PATENT SPECIFICATION

NO DRAWINGS

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COMPLETE SPECIFICATION

Improvements in or relating to the Manufacture of Sulphur Dioxide

We LAPORTE ACIDS LIMITED, a British Company, of Hunslet, Leeds, 10, Yorkshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the production of sulphur dioxide.

The production of sulphur dioxide by processes such as the burning of sulphur or pyrites is well known. It is also well known that the chemical reaction involved is highly exothermic. In practice it is usually very desirable, if not essential, to cool the resultant sulphur dioxide-containing hot gas before it can be utilised and it is highly desirable that heat extraction should be efficient and that optimum use should be made of the extracted heat.

According to the present invention there is provided a process for the production of sulphur dioxide by oxidation, and for extracting heat of reaction, which process comprises forming a sulphur dioxide, or sulphur dioxide-containing, gas stream in the combustion chamber of a gas turbine and passing the gas stream through the turbine to drive it, whereby heat is extracted and a cooled gas stream issues from the turbine.

The result of such a process is that heat is extracted from the gas stream and is converted into power produced by the turbine. Thus very efficient conversion is obtained. The turbine can be coupled to any suitable apparatus, for example an electric generator.

One preferred manner of forming the hot sulphur dioxide-containing gas stream is to burn sulphur in a suitable oxidising gas. The sulphur is preferably fed into the combustion chamber in the form of a molten stream or spray. Alternatively pyrites or other sulphide-bearing material can be burned and in this case a dust separator is situated between the combustion chamber and turbine to eliminate entrained dust and so at least substantially to reduce, abrasion of the turbine blades.

In a further alternative the hot sulphur dioxide-containing gas stream can be formed by the thermal decomposition of the waste sludge acid resulting from sulphuric acid purifying treatments of petroleum and lubricating oils. This material is hereinafter referred to as "waste sludge". Such waste sludge is a viscous material normally containing some unreacted sulphuric acid and up to as much as 50% of organic compounds such as dissolved hydrocarbons, sulphonates and sulphuric acid esters. Thermal decomposition of this waste sludge with a suitable oxidising gas produces carbon dioxide, sulphur dioxide, oxygen and steam.

The gas stream issuing from the turbine can be further cooled by passing it through a conventional waste heat boiler and the steam so raised can be used as such in a process or can be used for instance to drive a steam turbine for generating electricity. Alternatively or additionally, some or all of any residual heat in the gas stream from the turbine can be extracted by passing the gas stream through a heat exchanger to heat up the oxygen-providing gas before passage to the combustion chamber.

Suitable oxidising gases are oxygen, air, oxygenated air and any mixture of gases containing sufficient oxygen adequately to react with the sulphur or sulphide-bearing material or the waste sludge referred to above.

The oxidising gas will, of course, first be

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Price 25p

compressed by the compressor stage of the turbine and the compressed gas then fed either directly to the combustion chamber or by way of a heat exchanger as described above. The compressor stage can be a standard one, for example employing an axial, centrifugal or displacement type compressor.

The turbine can be either an axial flow or a radial flow type. The combustion chamber and turbine chamber and blades must, of course, be of material to withstand corrosion by sulphur dioxide. However, vulnerable surfaces will not normally be operating at temperatures below the dew-point of the gases involved and hence "wet-corrosion" should not occur. Suitable materials for the construction or lining of corrosion-vulnerable parts may be high chromium steels; nickel-chromium-cobalt-containing alloys; mixtures of ceramic materials and metals known as "cermets", or certain ceramic or refractory materials.

When sulphur is the material employed in the formation of sulphur dioxide the combustion chamber can be constructed of aluminium—a metal which is very suitable for use with molten sulphur and which also resists sulphur dioxide attack even at high temperature is efficiently cooled. Such cooling may be effected by constraining the molten sulphur to a helical cooling path around the walls of the combustion chamber and thence passing it into contact with the oxidant gas.

It will be appreciated that although only one compression stage and one turbine stage have been referred to throughout the foregoing, the invention is not limited to such precedure. Any normal duplication and/or combination of such stages may be employed.

One application of a process according to the present invention is in a sulphuric acid manufacturing plant. For example, by employing molten sulphur as the fuel the exhaust sulphur dioxide-containing gas stream from the turbine can be passed on to the contact section of the plant for production of sulphur trioxide (preferably it would first be passed through a waste heat boiler to raise steam for use elsewhere in the plant or in an associated plant).

Another substantial advantage arising from the present invention lies in its application to the decomposition of the waste sludge herein referred to. As stated above certain of the gaseous products so produced are sulphur dioxide, oxygen and steam. These can be recombined catalytically to reform a good grade of sulphuric acid. Thus in this particular embodiment of the invention one is enabled firstly to extract (as turbine power) considerable heat from that liberated during the combustion particularly of the hydrocarbons in the waste sludge, and secondly to convert other components of the sludge into forms well-suited for ready recombination in to sulphuric acid.

The following example illustrates the invention.

EXAMPLE

The turbine having a cylindrical combustion chamber has an air and sulphur burner at one end and an expansion joint to the turbine casing at the other. The chamber is made of 99.5% aluminium and is adapted for liquid sulphur cooling. In this manner the chamber has excellent corrosion resistance against sulphur dioxide and trioxide.

The arrangement for the liquid sulphur cooling consists of passages suitably formed and disposed in contact with the combustion chamber surface, being so arranged to ensure that in operation the temperature of that surface can be kept in about 300° C.

The burner is made from silicon nitride-bounded silicon carbide. It is in two halves; one being a large tube to carry primary air from a compressor and has the far end partially blocked by a plate inclined at 30° with the longitudinal axis. This plate blocks the top half of the tube but leaves an aperture at the bottom, which, with the end of the tube, is formed into a lip. Air can thus be formed into a jet coming out from under the edge of the inclined plate, to meet a stream of molten sulphur which can be led down the upper surface. In such a way the stream will break up and be atomised.

The other half of the burner is a simple tube for conveying molten sulphur to the top of the inclined plate. It is flattened at the end to spread the molten sulphur uniformly over the plate.

The flanges on the other ends of the two tubes are inclined to the axis of the two tubes so that the main direction of the spray of sulphur will be along the major axis of the combustion chamber they are mounted on, the end of the chamber being in such a position as to achieve this.

Secondary air from a compressor can be introduced into the combustion chamber conventionally round the burner. A slight constriction in the secondary air supply port ensures that the primary air pressure is always greater since both have a common source.

Situated in front of the burner where the flame will be hottest are five silicon nitride bonded silicon carbide rods which are flange bolted to the cylindrical portion of the combustion chamber and extending as radii inwards towards the hottest part of the flame. Three are solid and by their glowing ends act as hot spots to relight the atomised sulphur, should there be a temporary interruption, and thus prevent a "flame-out" and possible explosion. A fourth is formed into

a thermometer pocket in which is a thermocouple connected to a protector device e.g. for cutting of supply of molten sulphur in the event of, for instance, too high or too low combustion gas temperatures.

The fifth is hollow, acts like a gas igniter and is always connected to a supply of bottled gas. It is used for lighting when starting up and relights the sulphur should there be more than a momentary interruption in supply. Its position in space in the chamber is such that there is no possibility of its flame affecting the thermocouple pocket and is situated further back and to one side.

A compressor for use in the gas turbine comprises a conventional two stage centrifugal compressor. It supplies combustion air for the sulphur and for cooling the faces of turbine disc and pressurising the interstage and bearing labyrinths. There is an expansion joint between compressor and combustion chamber and then the air divides into primary and secondary supplies. There is a liquid cooled bellows expansion joint made of 99.5% aluminium between the combination chamber and the turbine.

The turbine has four stages and these and the two stages of the compressor are conventionally mounted on a single shaft. When an electric generator is to be driven from the compressor end of this shaft passes through a gear box which also drives the auxiliaries.

All the surfaces of the casing made from steel and in contact with the hot gases from the combustion chamber are sprayed with aluminium metal before the turbine is put to work in order to reduce oxidation and corrosive attack.

Finally, in operation, sulphur is burned in the combustion chamber in an air stream from the compressor. The gases, which contain sulphur dioxide and oxygen, which issue from the turbine are passed through a conventional waste heat boiler and thence, to convertors for conversion to sulphur trioxide in the known manner. The sulphur trioxide is finally passed to a conventional absorption system for conversion to sulphuric acid.

WHAT WE CLAIM IS:—

1. A process for the oxidative production of sulphur dioxide and for the extraction of the heat of reaction from the sulphur dioxide obtained, which comprises forming sulphur dioxide, or sulphur dioxide-containing gas, in the combustion chamber of a gas turbine by an oxidative process and passing this gas in a stream through the turbine to drive it, whereby heat is extracted and a cooled gas stream issues from the turbine.

2. A process according to claim 1, wherein the gas stream is formed from sulphur and an oxidising gas, suitably air or oxygen.

3. A process according to claim 2, wherein the sulphur is fed to the combustion chamber of the turbine in the form of a molten stream.

4. A process according to claim 1 wherein the gas stream is formed from "waste sludge" as hereinbefore defined, and an oxidising gas, suitably air or oxygen.

5. Apparatus for carrying out the process claimed in any preceding claim, substantially as described herein with reference to the Example.

6. In a contact process for the preparation of sulphuric acid, the step of employing a cooled sulphur dioxide, or sulphur dioxide-containing, gas stream from a process according to any one of claims 1 to 3.

7. In a process for the preparation of sulphuric acid by the catalytic combination of sulphur dioxide, oxygen and steam, the step of employing a cooled sulphur dioxide-containing gas stream from a process according to claim 4.

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